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TABLE 4. UNIT #4 BAGHOUSE PERFORMANCE TEST RESULTS.

BAGHOUSE PERFORMANCE TEST RESULTS

CONTRACT TEST REQUIREMENTS	FORMAL TEST RESULTS JULY, 1987 DESIGN	ACTUAL
* MEAN INLET VOLUME: (ACFM)	3,750,000	3,521,523
SYSTEM AVERAGE PRESSURE DROPS: (IN. W.G.)	6.8	4.23
EMISSION RATES: (GRAINS/ACF)	0.008	0.0015
EMISSION RATES: (#/MM BTU)	0.02	0.0050
STACK OPACITY: (%)	20	1.5–3.0
UNIT RATING: (MW)	820	836

* AVERAGE BETWEEN PITOT TUBE AND STOICHIOMETRIC VOLUMES

TABLE 5. FABRIC FINISH TEST COMPARISONS.

BAGHOUSE FABRIC FINISH COMPARISONS
UNIT #1 (GE I–625) VS UNIT #2 (I 625–G)

	GE I–625		I–625 G	
FABRIC TESTS EVALUATED	LOW	HIGH	LOW	HIGH
LOSS ON IGNITION:	4.5	5.7	4.6	5.6
PERMEABILITY:	36.2	54.0	41.8	49.6
MULLEN BURST:	565	821	757	901
TENSIL STRENGTH: WARP	480	579	645	699
TENSIL STRENGTH: FILL	285	335	362	392
MIT FLEX STRENGTH: WARP	17,000	41,000	36,000	41,000
MIT FLEX STRENGTH: FILL	2,860	5,830	9,639	10,905
ACID FLEX TEST: WARP	6,130	9,385	12,436	19,918
ACID FLEX TEST: FILL	446	1,042	2,920	3,259

4-8-87

THE DESIGN, START-UP AND INITIAL OPERATION OF THE INTERMOUNTAIN POWER PROJECT'S UNIT #1 820 MW FABRIC FILTER SYSTEM

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4/9/87

Picture of IPP

ABSTRACT

The Intermountain Power Project consists of two (2) 820 gross MW coal fired Units. This paper focuses on the design, start-up and initial operation of Unit #1 fabric filter which is the worlds largest fabric filter system. This system has been successfully in operation since March 28, 1986 with boiler loads as high as 840 MW. This project culminates the application of fabric filtration on the largest boiler scale to date with baghouses. This paper reviewes procedures in design verification, quality assurance and careful attention to detail, which in large part are responsible for this success.

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INTRODUCTION

The Intermountain Generating Station (IGS) consists of two 820 MW gross (761 MW net) pulverized coal fueled steam generators designed to burn Utah coal. Each generator has a maximum continuous rating (MCR) of 6,600,000 lb/hr steam @ 2,640 psig with a gross heat input of 8,352 million btu/hr. Each unit is equipped with an air quality control system (AQCS) consisting of a fabric filter (Baghouse) for particulate emission control, a wet scrubber for removal of sulfur dioxide, and a sludge conditioning system for disposal of combustion wastes.

Initial flue gas operation of the Unit #1 baghouse began on March 28, 1986 with commercial operation in June, 1986. Unit #2 baghouse began initial operation on February 16, 1987 and is expected to begin commercial operation in May, 1987.

This station is located 100 miles southwest of Salt Lake City, near Delta, Utah. The station owner is the Intermountain Power Agency (IPA), which is a sub-division of the State of Utah. Project management is provided by the Los Angeles Department of Water & Power (LADWP), who is also the largest single purchaser of Intermountain generating capacity.

Particulate emission guarantees are as follows: Total particulate emission rate at the stack shall be no more than 0.020 lb per million Btu of heat input to the steam generator, and opacity of the flue gas at the stack shall be no more than 20 percent opacity. Results of the particulate emission tests conducted during the week of August 4, 1986 and formal contract compliance testing conducted on March 3 and 4, 1987, are presented further in the paper in Table 5.

BAGHOUSE SYSTEM DESIGN

General Electric Environmental Services, Inc. (GEESI) provided each of Units 1 and 2 with a single (1) baghouse system consisting of three (3) separate casings, with 16 compartments per casing. Each compartment contains 396 filter bags for a total of 6,336 bags per casing or 19,008 bags per boiler. Design parameters are presented in Table 1 on the following page.

UNIT #1 SYSTEM DESIGN PARAMETERS

START-UP DATE	MARCH 28, 1986
MODEL NUMBER	(3)16-396-12-33
GAS FLOW RATES: (ACFM)	
PER BAGHOUSE	3,750,000
PER CASING	1,250,000
INLET FLUE GAS TEMPERATURES:	
(DEG.F.) DESIGN	285
RANGE	255 TO 305
DESIGN INLET DUST LOADINGS (GR/ACF)	0.8 TO 5.0
DESIGN OUTLET EMISSION RATE (#/MM BTU)	0.020
GAS-TO-CLOTH RATIOS: (CFM/SQ.FT)	
GROSS	2.0
* NET - 1 Compartment Off Line	2.15
* NET - 2 Compartments Off Line	2.3
SYSTEM DESIGN PRESSURE DROP (IN.W.C.)	6.8

* REVERSE GAS VOLUME NOT INCLUDED

TABLE 1

SCOPE OF SUPPLY

The scope of supply for the baghouse system was from the inlet flange to the outlet flange of the individual casings including all structural steel, insulation, hoppers, individual compartment inlet and outlet manifolds, bypass ducts, poppets, reverse gas fans and motors, compartment ventilation system, model study, filter bags, hopper heaters, and control enclosures with all devices required for automatic and manual control, including state-of-the-art computer controls.

Model Study

A 1:16 scale model study was performed to qualify the gas and dust flow performance.The model study consisted of two (2) phases. The first phase consisted of tests on the flange-to-flange fabric filter model under various conditions of operation. These investigations were conducted to determined the gas flow division between the individual casing compartments and to make any physical changes required to obtain satisfactory balance for the various conditions. For the operating modes investigated, gas flow division between compartments, pressure loss and flow/dust deposition were measured.

These various modes consisted of the following:

1. Normal system operation at 100% MCR with all casings and I.D. fans in operation.

2. 100% MCR system operation with all casings in operation with one I.D. fan simulated out of service.

3. 50% MCR system operation with all casings in operation with only two I.D. fans in operation.

4. 50% MCR system operation with one casing out of service, plus two I.D. fans off line.

5. 50% MCR operation with all casings in operation but with one air preheater simulated out of service and only two I.D. fans in operation.

The second phase of the model study investigated the ductwork external to the flange-to-flange baghouse. This was conducted to optimize the configuration of the ductwork system, in regard to controlled gas flow. This included gas flow distribution within the ductwork; incremental ductwork system pressure drop characteristics, and biasing of gas flow rate to individual casing and I.D. fan components. These tests were conducted from 50% to 100% MCR system operation. Photographs of the models used in our study are shown in Figures 1 and 2.

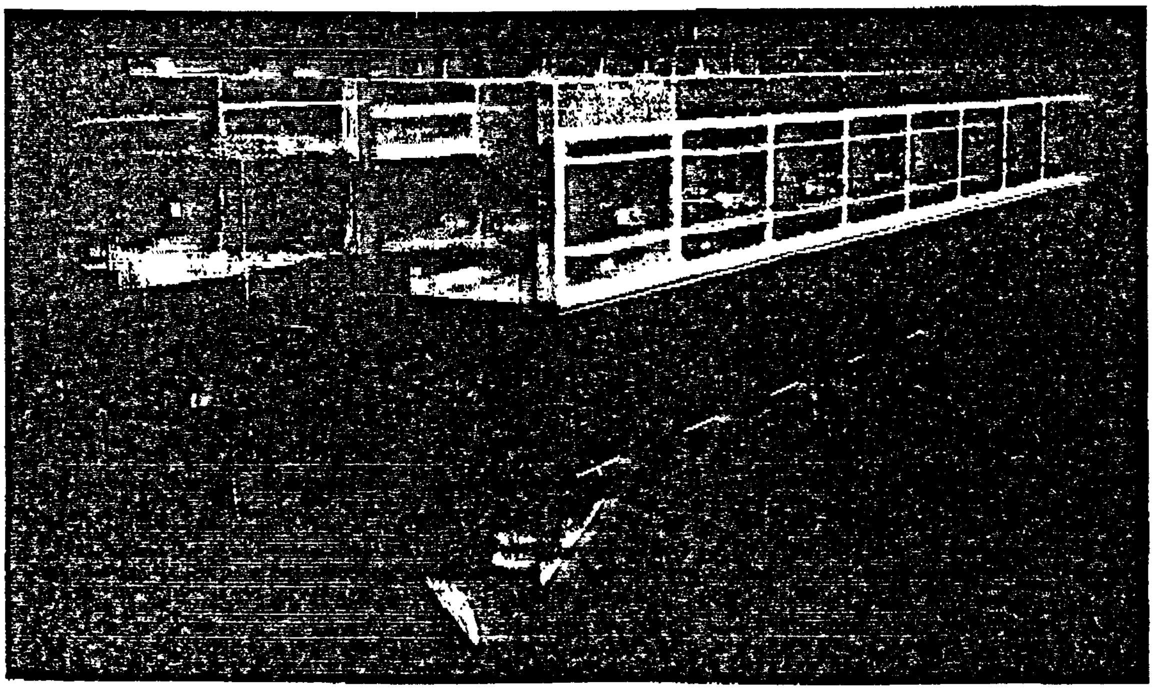

FIGURE 1

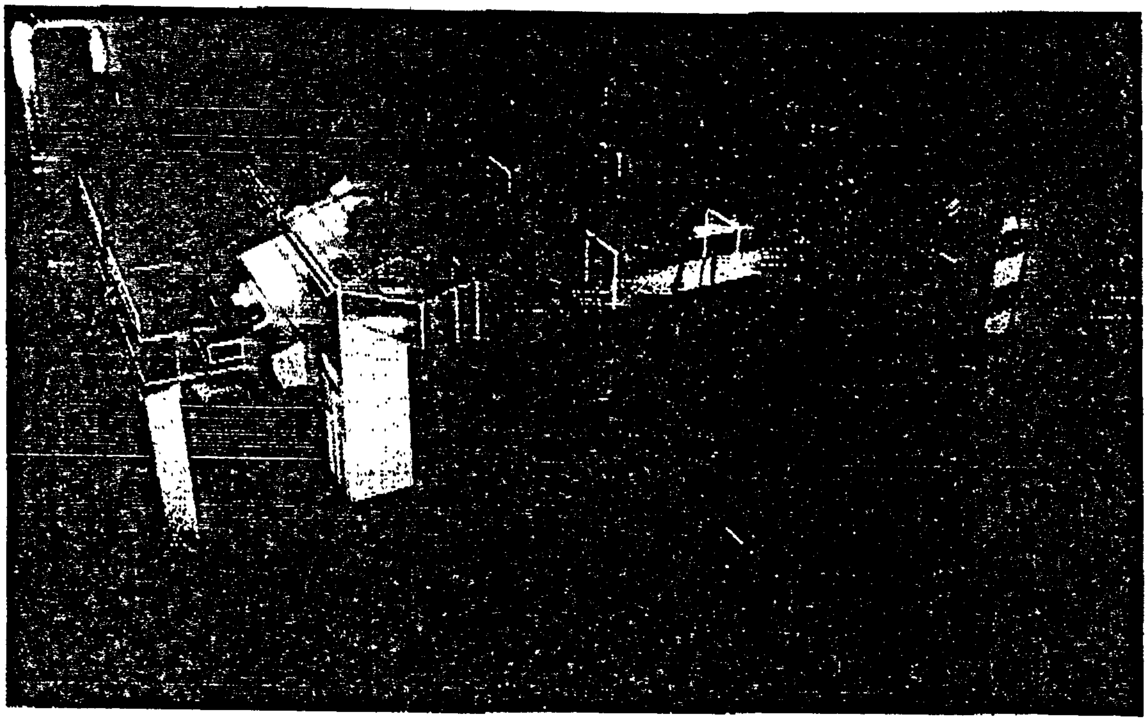

FIGURE 2

Bag Design

The filter bags are 12.0 inches in diameter by 33.0 feet long. The filtration material is 13.5 oz/yd sq. nominal weight woven fiberglass with a Burlington I-625 G acid resistant finish. (Figure 3) The filter bags were manufactured by Midwesco Filter Media Resources Division in Winchester, Virginia. Each bag was supplied with 8 anti-collapse rings located at variable spacings and is of a clampless design requiring no special tools to attach to the thimbles. To ensure meeting the highest filter bag standards, a stringent bag/fabric QA/QC program (2) was conducted. ETS, Inc. of Roanoke, Virginia conducted all tests required. Verification of test results were conducted by (LADWP) and (GEESI) QA/QC personnel. A summary of the Fabric Testing Acceptance Criteria is presented in Table 2.

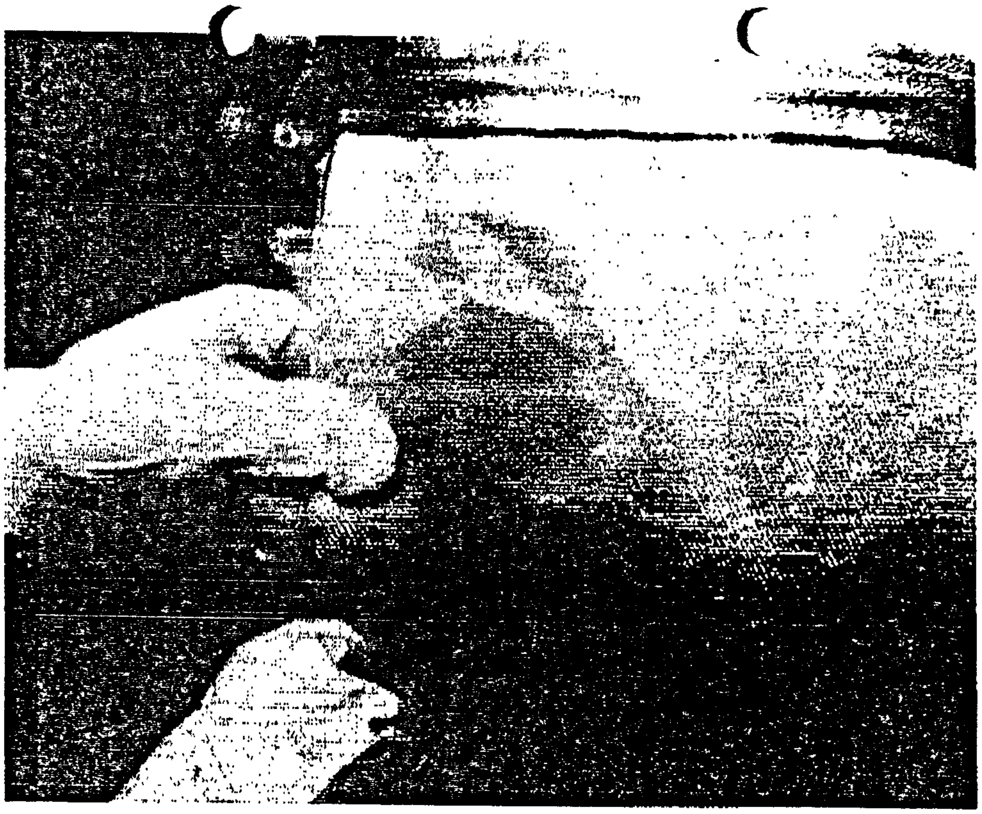

FIGURE 3

FABRIC TESTING ACCEPTANCE CRITERIA

FABRIC PARAMETERS	AVERAGE SPECIFICATIONS
WEIGHT (Oz/Sq.Yd)	12.825 – 14.175
COUNT: WARP	42 – 46
FILL	22 – 26
WEAVE	3 x 1 TWILL
PERMEABILITY (Cu.Ft/Min/Sq.Ft)	35 – 55
YARNS: WARP	37 1/0
FILL	75 1/0
LOI (%)	4.0 MIN.
MULLEN BURST (Lbs/Sq.In)	550 MIN.
TENSILE STRENGTH (Lbs/Sq.In)	
WARP	500 MIN.
FILL	275 MIN.
THICKNESS (In)	0.0137 – 0.0177
WATER DROP ABSORPTION	≤ 1"/30 MIN.
MIT FLEX (CYCLES)	
BEFORE ACID:	
WARP	8000 MIN.
FILL	2000 MIN.
AFTER ACID	
WARP	4000 MIN.
FILL	1000 MIN.

TABLE 2

Filter Bag Quality Assurance/Quality Control Program

Quality control proceedures were performed by the manufacturers of the fabric, sewing thread, caps, rings, and completed filter bags. The quality assurance was performed by LADWP,GEESI, and an independent test lab approved by all parties. All bags were manufactured to meet or exceed the requirements of a detailed and exhaustive specification prepared by GEESI and approved by LADWP and Black and Veatch (B&V).

A short time after bag fabrication began, production of the 40,000 bags needed for Units 1 and 2 was suspended by LADWP, B&V, and GEESI due to two problems. First, the test equipment used to determine weight, thickness, permeability, tensile strength, mullen burst, organic content, and cadmium plate thickness was not calibrated to an acceptable standard. Second, the specification did not stipulate whether or not the test criteria (e.g. sewing thread tensile strength of 12.1 lbs. per inch) was to be compared to the average of the required three test results per sample, or compared to each individual test result.

The test equipment was recalibrated to agreed upon standards. Initially, it was also agreed that the test criteria was to be compared to the average of the required three test results per sample. However, multiple point averaging can mask the effect of one failing test point. Failures can occur at defect areas which would compromise filtration ability. To minimize that possibility, the test criteria was modified to take the form of: The average of the three test results must be at least (X) and each individual test result must be at least 90 percent of (X).

Thus, LADWP and GEESI quality assurance compared each test result as well as the average of the three test results to a specific test criteria for acceptance or rejection of goods. This also allowed most of the material and bags to pass a severe test program but did not allow a very low test result to be averaged out.

As a result, the quality assurance/quality control group achieved its goal of producing bags of consistent and high quality. The actual bag performance and longevity, however, are determined in the field and are affected by parameters such as the type of coal burned and plant operation, which are not easily correlated to laboratory tests.

Bag Installation

The filter bags on Unit 1 were installed approximately 2 months prior to start-up. Procedures required immediate sealing of the compartments after the bags were tensioned. Details of the bag hanging procedure are as follows:

STEP #1 - Confirm that the hopper heaters are operable in the compartments to be bagged. Any thimbles with a bent lip or rough spots should be repaired and ground smooth prior to installing the bags to avoid damage to the bag upon installation.

STEP #2 - The boxes of filter bags are to be opened and the bags layed out still folded on top of the flattened boxes. This will prevent abrasion of the glass filter bags while resting on the thimbles. See Figure 4. The bags layed out along the outer walls are placed about 2 ft. from the wall so that they do not catch on the insulation support pins nor horizontal support members while the bags are being raised, and hung on the bag supports.

FIGURE 4

STEP #3 - As p[illegible] Figure 5 the filter bags (3) a[illegible] pulled up three at a time and attached at the top on the bag support bars, with the bag vertical seams facing the walkways. As soon as a section of bags have been pulled up and attached, the bag bottoms shall be placed on the thimbles as follows:

* The bag cuffs are placed over the thimble lip at an angle sufficient enough to allow it to be installed.

* Once the bag cuff is below the lip and wide part of the thimble, pull vertically upwards on the bag to secure it on the seat of the thimble. Make sure to check the full 360 degrees of the bag so that the bag compression band is up against the lip of the thimble. (Make sure that the vertical bag seam is straight and not twisted.)

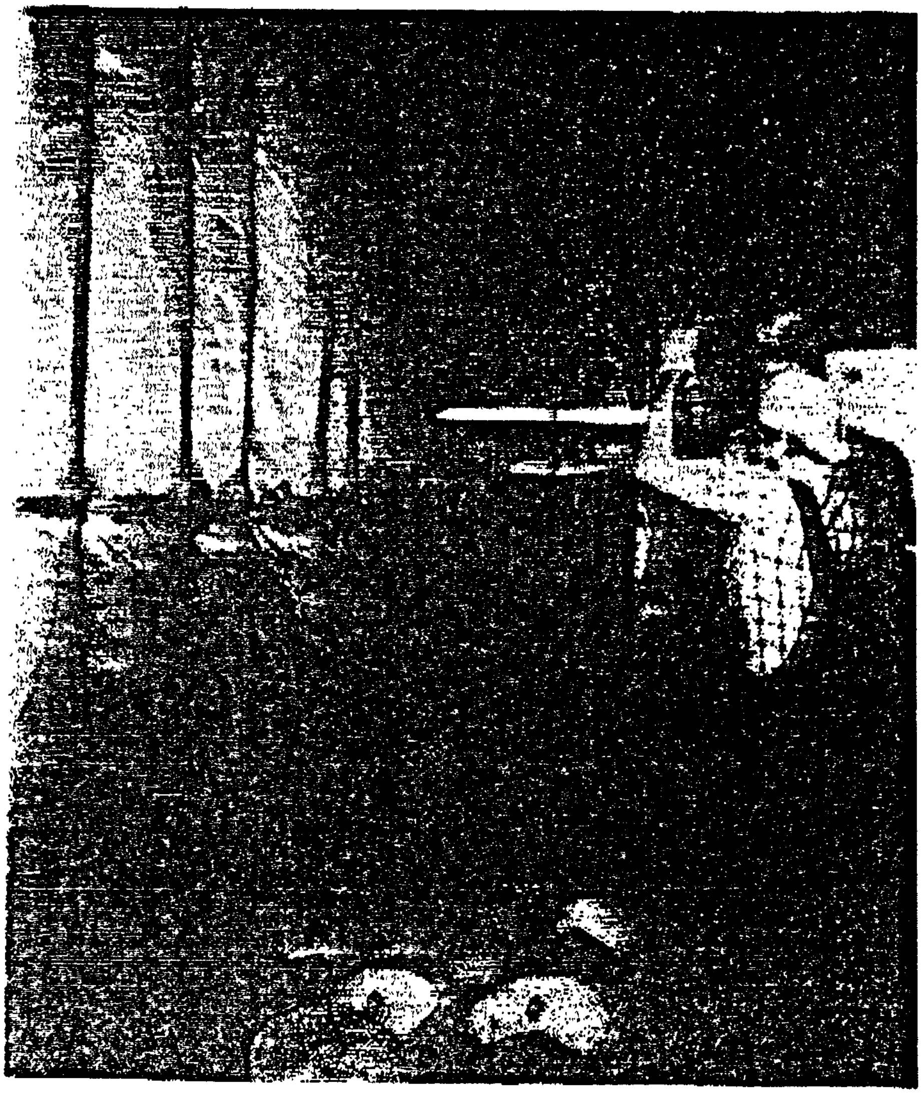

FIGURE 5

STEP #4 - After the compartment has had the bags installed, the bags must be fully tensioned to a preset minimum of 75 lbs. tension with the use of a pneumatic tensioning tool. The clevis pin is to be inserted through the closest and next lowest hole in the support bar above the washer. The bags are to be tensioned from the outside walls in towards the center of the walkways to allow for any takeup in the tube sheet.

STEP #5 - After all the bags have been installed and tensioned, the compartment must be cleaned of any debris and sealed. All compartment doors are to be tack welded shut and the hopper heaters turned on until after start-up to prevent unauthorized entry into the compartments and to prevent moisture condensation from occurring on the bags.

System Controls

The IPP control system consists of conventional control panels with handswitches, lights, indicators, recorders, annunciators, etc. and a "state of the art", cathode ray tube (CRT) based graphic system. The "touch screen" graphic system duplicates both control and indication, as well as the annunciation provided by the conventional control panels. One graphic system with redundant CRT units was provided for the baghouse system. The graphic systems communicate via a programmable logic controller (PLC) located in each of the conventional control panels. Either the graphic system or the conventional control panel can operate the baghouse independent of each other. An example of one of the CRT screens is shown in Figure 6.

The touch screen graphic system allows the operator control, and allows the operator to observe the system status and alarming of key components of the baghouse. The operator can, within seconds, move from one component system to another by just touching the screen.

The operator can control the process via the touch screens by selecting the required screen and component and touching the graphic symbol on the screen. The function requested is then performed by the PLC. Alarms are also displayed and acknowledged on all graphic screens as well as the main alarm screens. Active messages, as well as acknowledged and reset alarm messages, are displayed showing the time, day, message, and graphic number where the respective system is displayed.

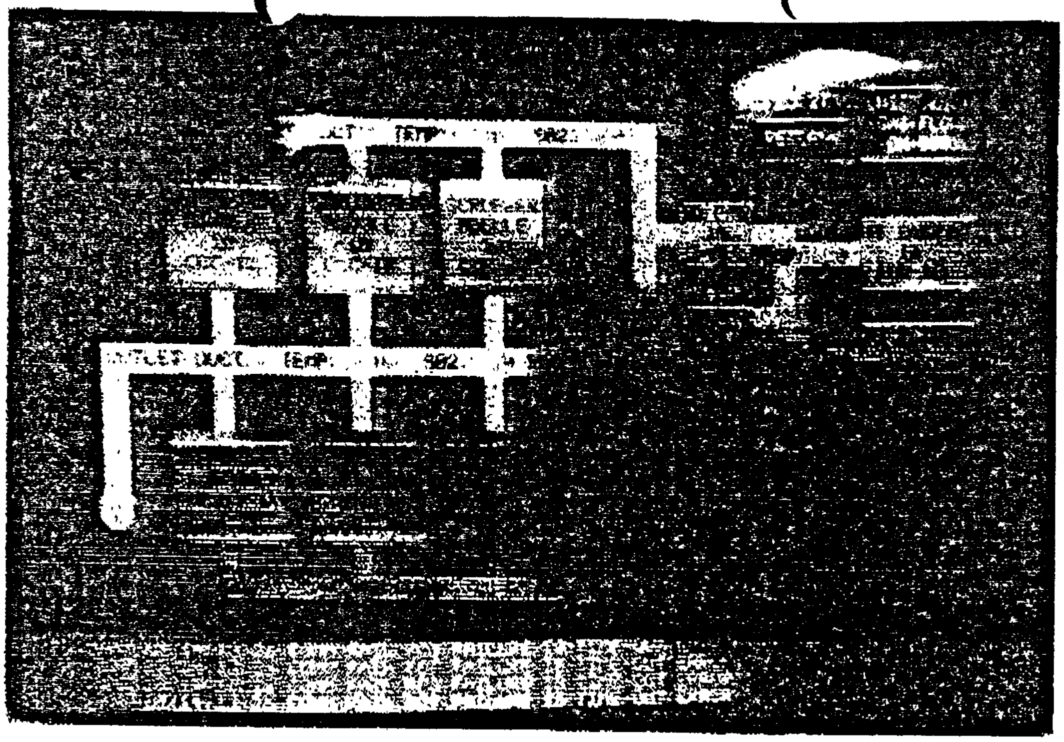

FIGURE 6

CLEANING PHILOSOPHY

At IPP, the three (3) individual casings per unit are treated as a single baghouse system. When any casing reaches it's preset pressure drop initiation level, all 3 casings start cleaning on a staggered basis, starting with casing A. This patented (1) cleaning method staggers the casings 70 seconds apart from each other, thus allowing the full flow of reverse gas into only one casing at a time. By doing this, the maximum system pressure spikes that accompany a cleaning cycle are minimized. The cleaning cycle can be initiated by any one of the following methods: 1. Casing Differential Pressure; 2. Preset Timer Override; or 3. Operator Initiated Cleaning (Manual).

In the differential pressure cleaning mode, Casings A and C are preset to clean at a initiation level of 5.4 IN. W.G. and Casing B cleans at 5.9 IN. W.G.. Casing B is cleaned at a higher level to offset the higher flow rates and associated pressure drops which will prematurely initiate a cleaning cycle on casings A and C. This flow imbalance may be due to either I.D. fan biasing or improper flow distribution within the baghouse. As indicated in Figure 7, Casing B will start cleaning 70 seconds after Casing A begins cleaning, and Casing C will start cleaning 70 seconds after Casing B has begun cleaning. The cleaning time per compartment is 3.3 min. as per Figure 8, with the compartments being cleaned from front to back as follows: 1, 9, 2, 10, 3, 11, 4, 12, 5, 13, 6, 14, 7, 15, 8, 16. At this point. the baghouse will revert back to the filtering mode until it again has had its cleaning cycle initiated.

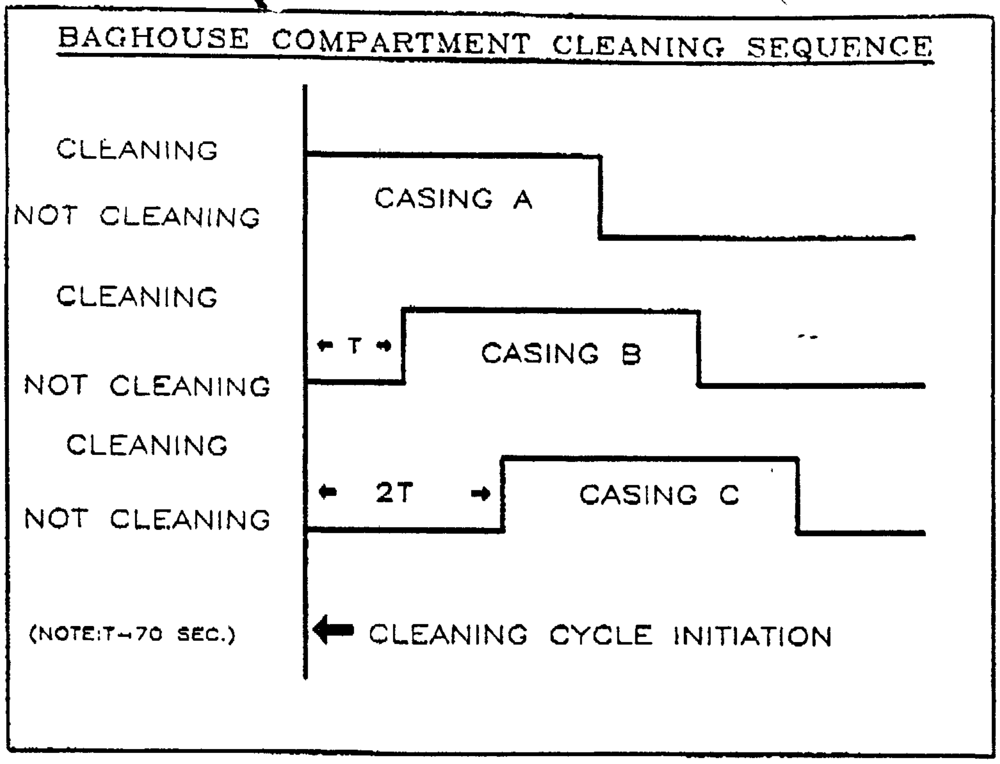

FIGURE 7

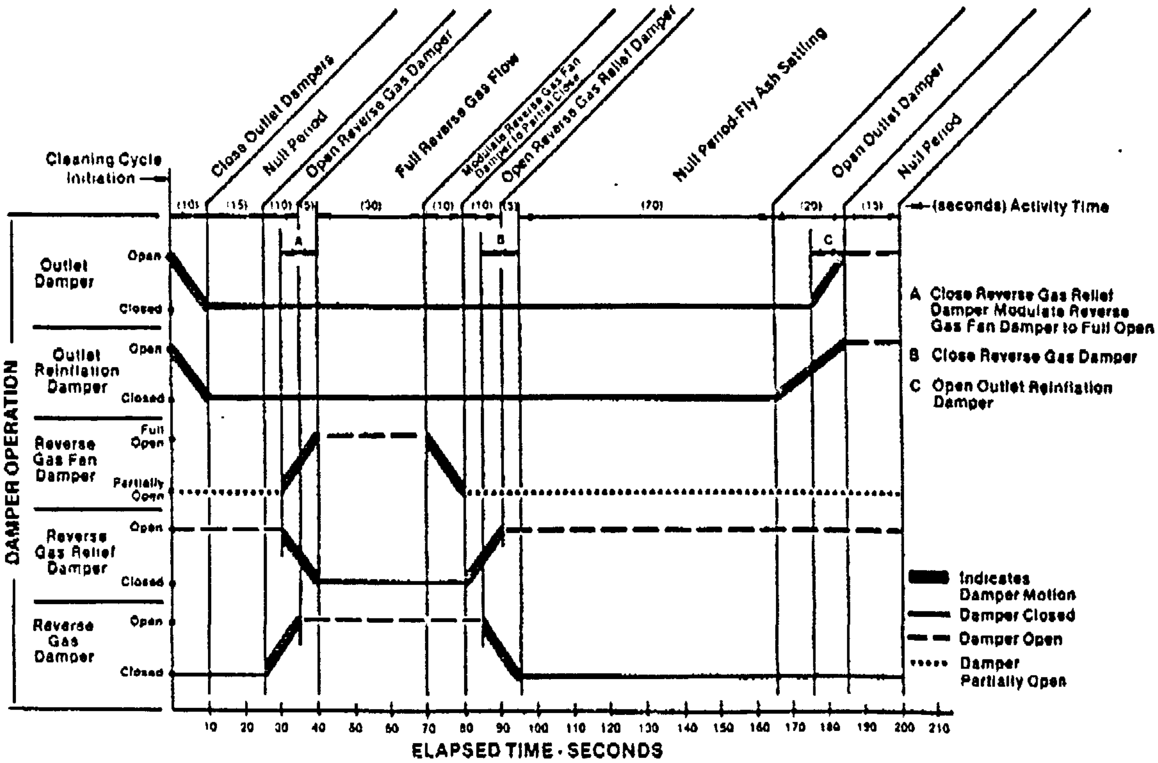

FIGURE 8

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OPERATING HISTORY

Precoat

The filter bags were precoated with flyash prior to initial start-up using a rigorous proceedure establisned by GEESI. The purpose of the precoat was to protect the clean surface of the new filter media from any potentially harmful constituents of the flue gas and/or boiler upsets.

The filter bags were estimated to require approximately 1.5 pounds of dry flyash per 10 sq. ft. of cloth. With a total of 1,970,608 square feet of cloth per boiler, approximately 1,478 tons of flyash was required to effectively pre-coat the filter bags to a required pressure drop rise of 0.5 - 1.0 IN. W.C. over the original losses. The pre-coat material was acquired from Utah Power & Light's Hunter Station. Several other boiler installations were evaluated for suitability, but were rejected as having ash un-suitable for pre-coat per GEESI's requirements. The ash analysis summary for this ash is shown in Table 3.

The pre-coat material was obtained from a pulverized coal boiler which met a specified maximum sulfur content of 1 per cent, a minimum mass mean particle size distribution of 8 microns with less than 1% being less than 1 micron, and sodium oxide (Na_2O) level of less than 2.0 %. These specifications were developed to obtain a base layer of ash on the bags which was non responsive to moisture and/or acids which may be present during startup. It also provides an ash in the expected particle size range of the coal being fired at the plant.

UNIT #1 PRE-COAT MATERIAL

ASH ANALYSIS SUMMARY

% ALUMINUM OXIDE	Al2O3	–	17.99
% CALCIUM OXIDE	CaO	–	8.02
% IRON OXIDE	Fe2O3	–	4.13
% MAGNESIUM OXIDE	MgO	–	1.90
% PHOSPHORUS PENTOXIDE	P2O5	–	0.46
% POTASIUM OXIDE	K2O	–	0.92
% SILICA	SIO2	–	56.77
% SODIUM OXIDE	Na2O	–	1.67
% SULFUR TRIOXIDE	SO3	–	0.80
% TITANIUM OXIDE	TIO2	–	1.07
% LOSS ON IGNITION	LOI	–	5.12

FLYASH SOURCE: UTAH POWER & LIGHT, HUNTER STATION

TABLE 3

Precoat (Continued)

The hopper heaters were turned on 1 week prior to pre-coating the bags to ensure a hot, dry environment in the compartments to avoid any moisture condensation on the filter bags. Air temperatures above 140 Deg. F were observed in the compartments from the hopper heaters alone.

Precoat began on March 19, 1986 at 8:29 A.M. and was finished by 6:00 P.M.. Figures 9 - 11 show the initial clean bag pressure drops **(Black Bars)** vs the pressure drops across the precoated bags **(Hatched Bars)** at design flow rates. A minimum rise of 0.5 to 0.75 IN. W.C. pressure drop was required to indicate properly coated bags. A total of 4 compartments were coated at a time to ensure obtaining desired flow rates. Prior to injecting the ash into ports located in the inlet manifolds, the boiler was operated with the baghouse on bypass to reach temperatures in excess of 200 Deg. F.. The boiler flames were then extinguished and air was pulled through the boiler into the baghouse to provide clean, hot, dry air to transport the ash during pre-coat.

The hoppers were examined for drop-out after the pre-coating was completed. The survey indicated that drop-out was heaviest towards the inlet end of the baghouse, with hopper ash levels in one compartment reaching as high as two-thirds from the bottom of the hopper access door. The remaining hoppers ranged from as high as 3 ft. below the hopper access doors, with each successive hopper having less than the prior one. This was probably due to a low carrying velocity in the manifolds, thus allowing drop-out to occur towards the inlet end of the baghouse casings.

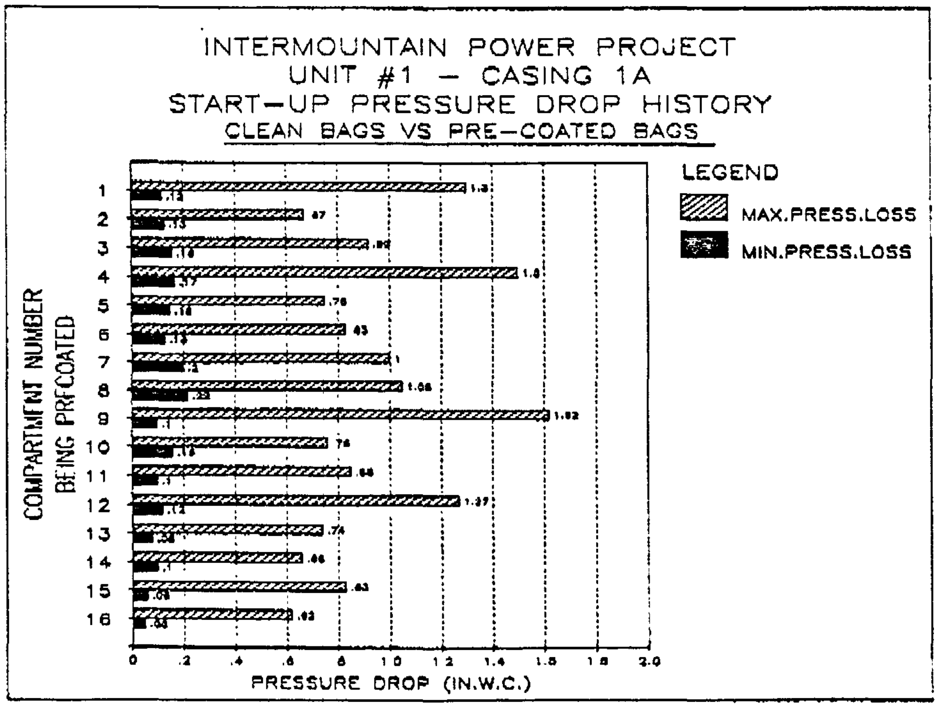

FIGURE 9

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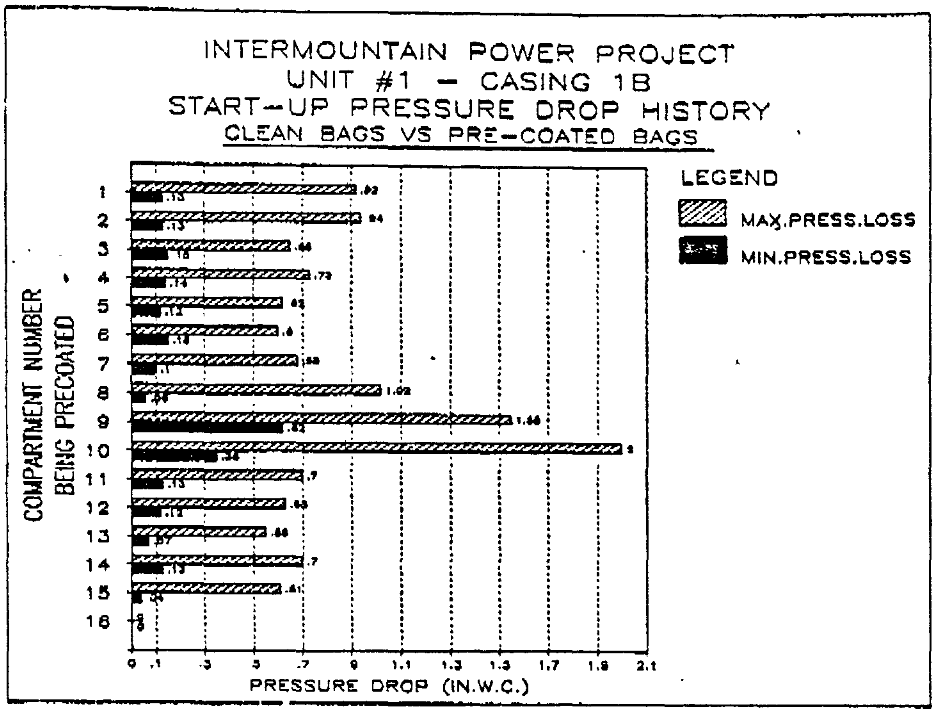

FIGURE 10

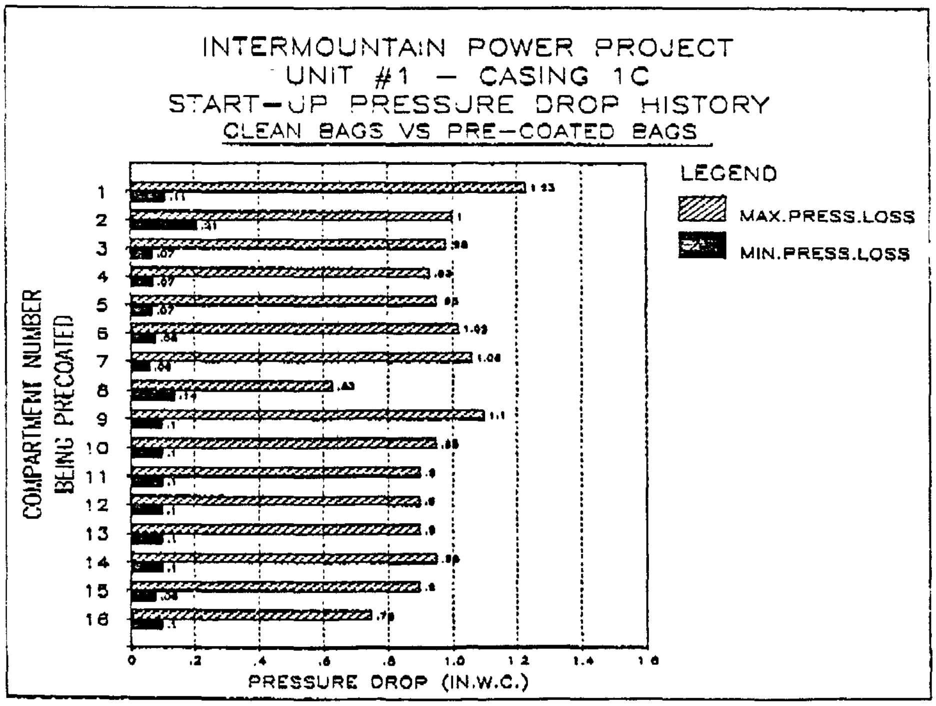

FIGURE 11

IP12_006558

Initial Start-up

The baghouse was placed into initial operation on March 28, 1986 at 10:00 A.M.. The generator load was 360 MW, with inlet baghouse temperatures of approximately 280 Deg. F., inlet flow rates of around 700,000 ACFM, and casing pressure drops at 1.2 IN. W.C.. Generator loads were increased to 540 MW towards the late afternoon, with pressure drops remaining about the same. The first cleaning cycle occurred at 3:40 A.M. on March 29 th. with peak pressure drops of 5.8" during cleaning. The baghouse casings triggered their cleaning cycle at 5.4", and boiler loads were 700 MW. Boiler loads of 800 MW were reached by the end of the day.

The first compartment to see flue gas was compartment 16 in B Casing. This compartment had no filter bags installed and was used as a condensation vent to allow a free path for the initial slug of flue gas to pass through and carry with it any condensation that may have occurred in the inlet manifold in the week following pre-coat. This compartment was later installed with bags following a required 500 hour bag seasoning period.

Coal Supply

The initial coal fired at the IPP facility is mined in Utah. This coal is a low-sulfur, high grade, bituminious coal. A typical fuel analysis for this coal is shown in Table 4.

TYPICAL FUEL ANALYSIS

PROXIMATE ANALYSIS (%)	AS RECEIVED	DRY BASIS
MOISTURE	5.15	*
VOLATILE MATTER	40.10	42.30
FIXED CARBON	44.80	47.20
ASH	9.89	10.40
ULTIMATE ANALYSIS (%)		
SULFUR	0.48	0.51
CARBON	67.70	71.40
HYDROGEN	4.27	4.51
NITROGEN	1.26	1.33
OXYGEN (By diff.)	11.20	11.90
GROSS HEATING VALUE (Btu/lb)	12010	12660

TABLE 4

BAGHOUSE OPERATING HISTORY

Pressure Drops

The system pressure drops have been well within contract requirements since initial operation. Due to a computer programming error, the baghouse casings were operating as independent units during the first few months. As a result, system pressure drops spiked as high as 7.0 " W.C.. As a result of these sp es, it was determined that the casings were not cleaning like a single baghouse system as per design. In fact, as many as 6 compartments were off-line for cleaning at any one time due to an improper timer setting. This problem was quickly identified, and the program error remedied which reduced the baghouse system pressure drop spikes by over 1" W.C. almost immediately.

Boiler loads have continuously increased on the average since start-up. Figure 12, shows the average monthly peak pressure drops, megawatts, and number of compartments out of service for maintenance vs time since May of 1986. Both loads and pressure drops can be seen to level off since November. Figure 13 shows the same information but over the 2 week test period of February 23rd through March 6th., 1987.

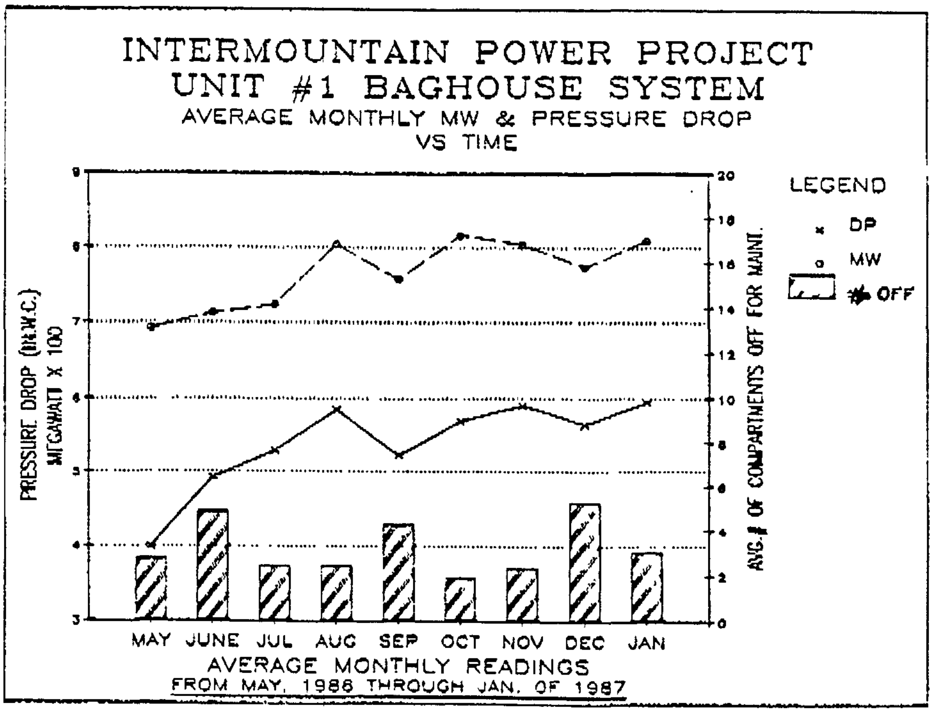

FIGURE 12

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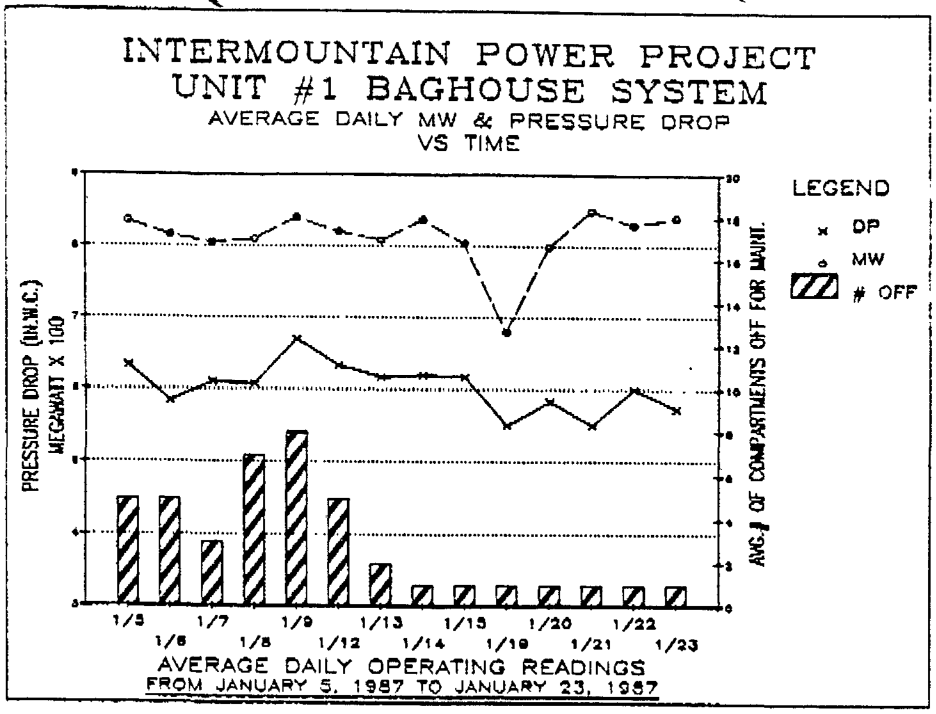


FIGURE 13

Performance Test Results

Table 5, presents the test results from both a preliminary test conducted by GEESI in August of 1986, and the formal contract test results conducted in March of 1987. These results are as follows:

UNIT #1 BAGHOUSE

PERFORMANCE TEST RESULTS

PERFORMANCE TEST REQUIREMENTS	PRELIMINARY TEST AUGUST, 1986	FORMAL TEST MARCH, 1987
MEAN VOLUME: (ACFM)	3,634,316	3,586,502
PRESSURE DROPS:		
Design (IN. W.G.)	6.80	6.80
Actual (IN. W.G.)	5.93	5.73
EMISSION RATE:		
(#/MM BTU)	0.0035	0.00233
(Grains./ACF)	0.0012	0.00057
OPACITY (%)	1-2%	1-2%
GROSS MEGAWATT	840	840

TABLE 5

Opacity Excursions

During the first few weeks of operation, the opacity levels in the compartments started to rise above expected levels. At first it was thought to be caused by new ash penetrating the new fabric, and was expected to decrease. This was not the case however, and since it was still during the 500 hour seasoning period, no compartment entry was made to try to determine the cause of the high opacity.

During a trip to the site by GEESI engineering, it was discovered that opacity spikes had increased to the point that no one compartment could be distinguished from any other. The baseline opacity averaged around 10-12%, with spikes up to 50%. Entry of a compartment was quickly arranged and it was determined that multiple bags had come off the thimbles causing adjacent bags to be destroyed and/or damaged. A full baghouse compartment inspection program was conducted. To date, approximately 411 bags have been replaced in all 3 casings. Of these, 59 actually came off the thimbles with the remainder damaged due to contact from these bags. In addition to these bags, 164 bags were damaged when a compartment access door was accidentally left open, (after a routine inspection) while a compartment was brought back on line. As soon as these bags were replaced, the opacity levels returned to normal levels of 1-2%.

Baghouse Maintenance Requirements

Thimble Repairs

During initial operation, an unusually large number of filter bags came off their thimbles causing other adjacent bags to fail as a result. This amount, although less than 1/2 % of the total number of thimbles in Unit 1, was substantially more than expected. A complete investigation of the cause of this occurrence revealed that a similar percentage of thimbles were out of the specified tolerance range of 11.825 to 11.855 " dia.. Even though the degree of variance from this specification was extremely small, with a clampless thimble/bag design, this dimension is critical. A 100 % inspection was made of all the thimbles utilizing a pie gauge to measure the thimble diameter. It was decided based upon the findings to repair all thimbles which were not within this specified range.

To complete this task, various methods were investigated from splitting the thimbles and re-welding them, to replacing all the defective ones. Both of these methods were rejected due to time and cost constraints. A task force was quickly formed to investigate other potential field repair methods. Of these one was developed and implemented.

Thimble Repairs (Continued)

A thimble enlarging device was designed and built by GEESI field construction, which actually cold rolled the thimble to within required tolerances. This device consists of three rollers which can be adjusted to push out equally on 3 sides of the thimble. By turning this device within the thimble with the use of a ratchet, the entire thimble can be expanded. This device is shown in Figure 14. With this device, all thimbles which measured out of tolerance were quickly repaired in Unit 1 as well as Unit 2.

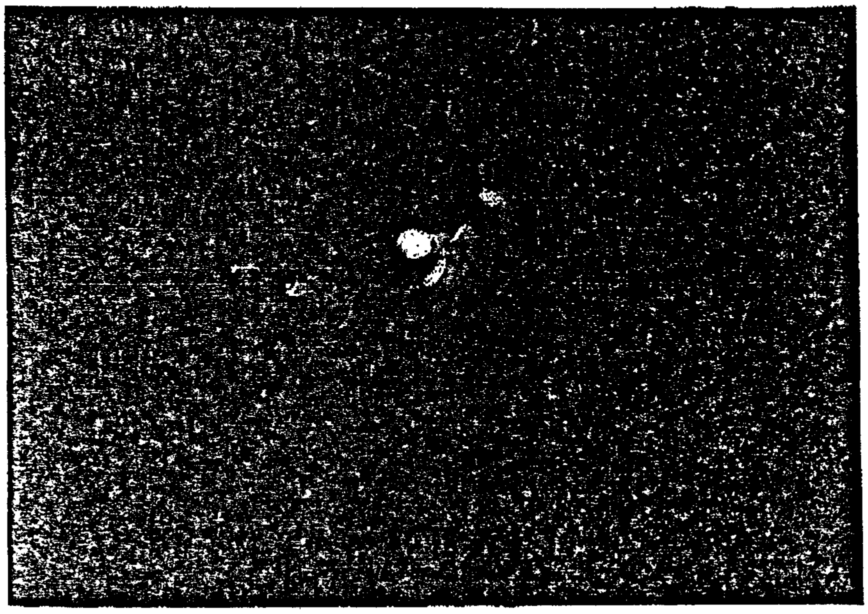


FIGURE 14

Hopper Gaskets

The original hopper door gaskets consisted of a 3/4" closed cell Viton Sponge Gasket. This was replaced with a fiberglass braided gasket due to high temperatures in the hopper area surrounding the hopper access doors. These high temperatures were caused by the "poor" location of the hopper heater temperature sensing probe which allowed the heaters to remain on continuously. The probe is located in the hopper throat area where the least amount of heat is present. These heaters provide 40 KW per hopper which generates localized skin temperatures of approximately 400 deg. F.. Prolonged exposure to this temperature exceeded the capability of the Viton material creating very hard, cracked gaskets. After careful evaluation, it was decided that the most cost and time effective remedy would be to replace the gaskets with the higher temperature material suitable for 1000 deg. F. operation vs. the relocation of the temperature probes.

Reverse Air Duct Expansion Joints

The original Butyl rubber reverse air expansion joints had to be replaced due to cracking caused by exposure to flue gas in excess of design temperatures. These joints were rated at a maximum of 325 degrees F., which was the original baghouse bypass temperature set point. An over temperature condition took place which may have caused the ductwork joint to deteriorate. The joints have since been replaced with a Viton reinforced material to allow for exposure to higher temperatures.

Hopper Evacuation System Problems

The hopper evacuation system developed faulty valves which allowed ash to continuously leak into the hoppers via the pressure equalizer lines. These lines shaped like an upside down U, developed holes in the upper knee of the curve within the hoppers which resulted in ash jetting up towards the bags, through the thimbles resulting in numerous bag failures. These holes looked liked bag test swatches that were actually cut out of the bags. It was by chance that the actual cause of the bag failures was found. Since then, the system has been repaired, and bag failures caused by this problem have stopped.

AVAILABILITY IMPROVEMENT TASK FORCE (AIP)

The Intermountain Power Project was a prime example of what a good working relationship between customer, architectural engineer, and equipment supplier can achieve. Each organization can contribute to produce a final baghouse design and operation based upon industry and personal experiences.

Problems are always preventable in hindsight. However, given the importance of achieving flawless operation, a new approach to problem solving was implemented. This was done through the formation of an Availability Improvement Task Force (AIP), which involved joint representation from LADWP, B&V, and GEESI along with outside consultants when deemed appropriate. Regular meetings provided a forum for ideas, changes, and/or concerns to be expressed and actions based upon facts vs speculation. Task items were identified, logged and the parties assigned the task of accumulating the appropriate data to either defend the proposal, reject it, or pursue additional information to achieve a good decision.

AVAILABILITY IMPROVEMENT TASK FORCE (AIP) (Continued)

This approach worked extremely well on this project. Examples of some of the major design changes, modifications, and additions which were a direct result of this committee were the following:

* Hopper Heaters were increased from 15 KW as quoted to 40 KW to provide a minimum interior hopper wall temperature of 150 Deg. F. above ambient prior to fabric filter operation and 250 Deg. F. minimum during operation. This has been a benefit during both start-ups and shutdowns by maintaining the compartment internal temperatures well above the moisture dewpoint, thus minimizing occurances of condensation on the filter bags. This may have resulted in the low filter bag pressure drops of around 5.8 IN. W.C. and bag weights of only 35-40 lbs. after one year of operation.

* Both the bag material and finish were evaluated by the committee prior to selection. Both 9-1/2 oz. and 13-1/2 oz./sq.yd. woven fiberglass materials and Teflon B and Acid Resistant finishes were evaluated and the heavier weight material with an acid resistant finish was selected. The heavier weight fabric may be instrumental in providing the low emission levels. This is based upon the fact that there are approximately 40% more individual fibers in the 13-1/2 oz. material vs. the lighter 9-1/2 oz. material. No conclusions have been made as to the effectiveness of Teflon B, vs Acid Resistand finishes.

* A Broken Bag Detection System was implemented into the Modvue programmable control and the main control panel. The Modvue displays the specific compartment number for which a broken bag is detected. A "Broken Bag" alarm is also provided on the main control panel which alerts the operator that an opacity excursion has occured in a specific compartment just after the bags in that compartment have been cleaned and the compartment placed back into service. This system, which utilizes the individual casing's opacity monitors, has been invaluable in the early detection of faulty bags and their quick replacement.

These are just a few of the many items investigated and implemented. Although many were not chosen for implementation, the disciplined evaluation ensured that each item was given equal weight in consideration.

SUMMARY

Since start-up, the Unit #1 baghouse system has been in operation with few major problems. The unit has operated in compliance with the contract requirements of 0.020 #/MM Btu. and less than 20% opacity. System pressure drops are approximately 1" W.C. below the guarantee level of 6.8" W.C. after approximately 1 year of operation. It is anticipated that this system will continue to operate well, at least through the three (3) year bag life guarantee period.

SUMMARY (Continued)

It is likely that the successful operation is the result off many factors beyond the design, including the coal being burned and startup/operating proceedures. All of these items contribute to a successful installation.

To summarize, we believe that the key items that have contributed to the success of this project are as follows:

Proper System Design: The design of the system should be a joint effort based upon the accumulated experiences of the industry as a whole including the equipment supplier, the architect/engineer, and the customer. All have relevant experience covering different perspectives which, when combined, yields the best possible design.

Availability Improvement Task Force (AIP): This committee helped ensure that the best of all technologies was considered in the final design. This included controls, materials of construction, bag materials and coatings, reviewing the results of the bag QA/QC program, startup proceedures and general operation.

Detailed System Model Study: The model study has again proven itself to be esential in proper baghouse system design. This provides verification of mechanical pressure drop and flow balances, prevents excessive drop out of fly ash in the ductwork and improves overall mechanical system pressure loss through optimized vaning and distribution devices.

Proper Bag Design: The selection of the fabric material, weight, weave, and applied finish has a great impact on the general operation of the baghouse and its tolerance to upset conditions such as boiler trips, tube leaks, and cleaning forces. The combination of the heavy weight fabric and the acid resistant finish may contribute to the extremely low particulate emissions and low casing pressure drops along with its tolerence to boiler upsets.

Bag QA/QC Program: This program ensured materials within specification. The program, as described in this paper, covers all aspects of the bag design including the finish, weave, strengths, weights, caps, threads, rings, and bag-to-thimble fit. This fit is essential in ensuring a tight seal in a clampless thimble design.

Proper Bag Installation: The bags must be installed properly on the thimbles and tensioned to their required force. Without proper tension, the bags can become loose during operation and actually come off the thimbles causing surrounding filter bags to be damaged. The bag-to-thimble fit is critical in obtaining low emission levels as experienced on Unit #1. Final results are indicative of 100% of all 19,008 bags having an acceptable fit and seal.

Ideal Coal For Baghouses: A coal low in moisture, sulfur, and sodium, may compliment the ability of a baghouse to provide low pressure drops.

Precoat: There are many arguments both pro and con relative to the use of precoat. It can be argued that it is better, not to precoat, but to bring the baghouse slowly on-line with its own boilers flyash. Others say that you should protect the fabric as much as possible using another source of material having ideal filtration, moisture and acid resistant properties. It was decided to precoat using the best ash posssible. The use of precoat has produced protection during startups and shutdowns from the condensation of acids and/or moisture. This has also provided protection during boiler upset conditions such as black outs when purging of the baghouse wasn't possible.

Proper Startup Procedures: Proper startup proceedures contributed to the successful operation of this baghouse. These procedures included 1) preheating the casings above the moisture dewpoint before exposing the bags to flue gas and 2) venting the initial slug of flue gas that is trapped in the inlet manifold. (At IPP, compartment B-16 was used as a condensation vent)

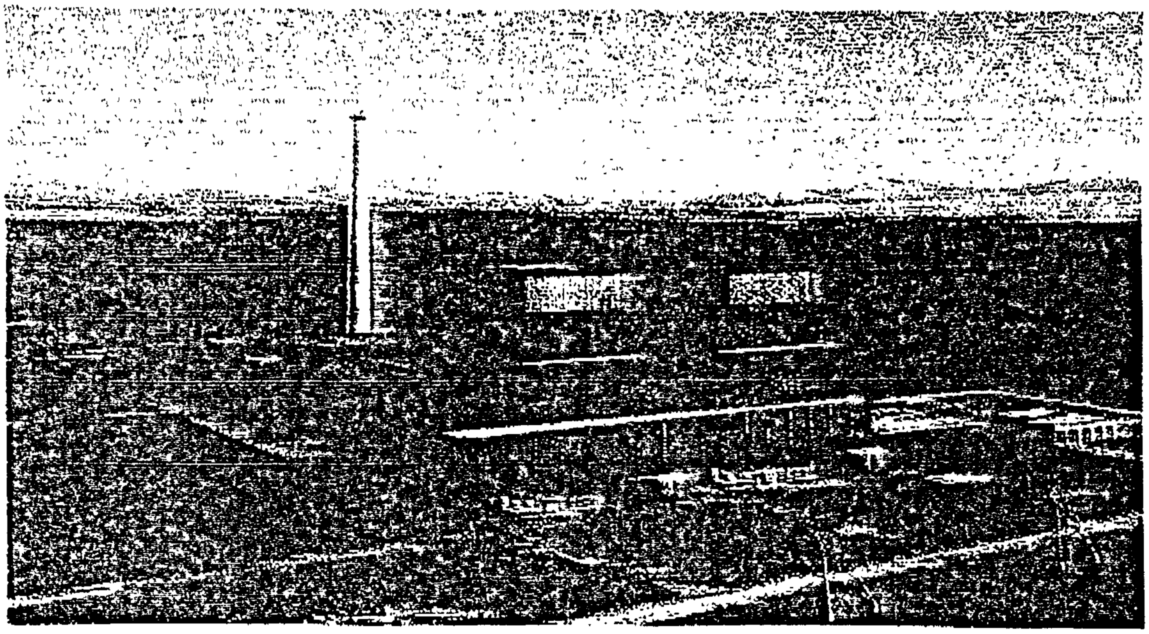
These are key factors in a successful baghouse installation. A lot of thought went into the quality assurance of all these items since the beginning of the project. They, in combination with the right amount of serendipity, have yielded a superb operating system.

REFERENCES

(1) U.S. Patent No. 4,507,130
Staggered Method Cleaning Cycle
For Fabric Filter System
Including Multiple-Baghouses
Alfred H. Roth, Inventor
General Electric Environmental
Services, Inc., Assignee

(2) Extending Fiberglass Bag Life
Miller, Zourides, Budrow
World Filtration Conference III
September, 1982

(3) Figures 3, 4 and 5 Courtesy of
ICI Advanced Materials
Suppliers of FLUON PTFE
To Burlington Glass Fabrics



IP12_006568

A CLEMSON UNIVERSITY CONFERENCE

DEVELOPMENTS IN FILTRATION TECHNOLOGY

File: ~~13-1460~~

APRIL 15–16, 1987

AT THE

RAMADA INN
CLEMSON, SC

Develop
FILTRATION

CONFERENCE
STANLEY ROSS, EMERY CHEMICALS, AND

ABOUT THE CONFERENCE

Textile materials are being used extensively in the filtration of 'wanted' and 'unwanted' particles from liquid or gaseous media. The filtration industry has made tremendous advances in addressing specific problems e.g., the filtration of hazardous gases, cotton dust, etc., by using textile fibers suited to the particular situation. There is still a lot that we need to learn about filtration. This conference is organized to answer some of the questions that the users and manufacturers of filters from fibrous structures are going to address.

The presentations will focus on instrumentation for measuring particle size, manufacture and developments in the design of baghouses, use of novel fibers in filtration technology, nonwovens and woven fabrics used in filtration of gases and liquids and techniques to determine pore sizes and pore size distribution in filter media made from fibers. The speakers represent a diverse group, drawn from utility and automotive industries, research institutes, baghouse manufacturers, fiber manufacturers, users of filter materials and universities, who will focus on the latest developments in the field of filtration.

Wednesday, April 15

8:00 REGISTRATION Ramada Inn (CONTINENTAL BREAKFAST AVAILABLE)

8:30 **WELCOME TO CLEMSON**

MODERATOR: E. A. Vaughn, Director, School of Textiles, Clemson University

8:45 STATUS REVIEW OF FEDERAL AND STATE TOXIC AIR POLLUTION REGULATIONS
Joseph Laznow, Senior Scientist, Enviroplan, Inc., West Orange, NJ
The development of federal and state toxic air pollution regulations will be reviewed, including the implication to industry of these regulations and pending legislation.

9:30 BAGHOUSES AS APPLIED TO MUNICIPAL SOLID WASTE INCINERATION
John McKenna, President, and Dale Furlong, Vice President, ETS, Inc., Roanoke, VA
Municipal solid waste is currently the most dynamic field for the application of baghouses This presentation will address both the technical and economic issues that this relatively new application for baghouse emission control raises.

10:15 REFRESHMENTS

10:30 DESIGN, START-UP AND OPERATION OF INTERMOUNTAIN POWER PROJECT'S UNIT #1 820 MW FABRIC FILTER SYSTEM
Richard L. Miller, Senior Engineer, General Electric
Environmental Services, Inc., Lebanon, PA
The Intermountain Power Project, consisting of two 820 MW coal-fired boilers, will be discussed, including design, startup, and operation of Unit #1, which is the world's largest fabric filter system. This system has successfully been in operation since March 29, 1986, with an average boiler load equal to 840 MW.

11:00 PROCESSING AND END-USE PERFORMANCE OF FINISHED GLASS FABRICS FOR FILTRATION
Melvin W. Westley, Senior Technical Specialist
DuPont Polymer Products Division, Wilmington, DE
The selection and proper application of a high-temperature lubricant to protect glass yarns from self-abrasion during cleaning cycle flexing will be discussed from the standpoint of successful long-term baghouse operation Also discussed will be fabric finish processing methods and types of fabric weaves currently in use, quality control and testing factors, and the relationship between laboratory and field performance

11:30 THE USE OF WOVEN FIBER GLASS FABRICS IN AIR FILTRATION
Dennis J. Vaughan, Corporate Director, Research & Development Division
Clark-Schwebel Fiber Glass Corporation, Anderson, SC
This presentation will outline various surface treatments used on glass fabrics to enhance their performance in hostile environments Both physical test data and photomicroscopy will be used to illustrate the various criteria.

12:00 **QUESTION-AND-ANSWER SESSION**
(Featuring Speakers of the Morning)

12:30 LUNCH

1:30 NONWOVENS AND FABRIC FILTRATION
Lutz Bergmann, President, Filter Media Consulting, Inc., LaGrange, GA
This presentation will cover the use of nonwoven textiles in dry and liquid filtration An overview of total sales for this media in the United States, related to 1986 will be given

2:00 STRUCTURAL ADVANTAGES OF NEEDLEFELTS IN FILTRATION
Roy B. Parker, Product Development Manager, Tex-Tech Industries, North Monmouth, ME
A comparison between current nonwovens will be presented, which will show a contrast of wovens and nonwovens, and will detail needlefelt technology.

2:30 CONSOLIDATION OF NONWOVENS AND FILTRATION PERFORMANCE
Edward A. Vaughn, Director, School of Textiles, Clemson University
The relationship between the geometry of needle punched nonwoven fabrics and filtration performance will be discussed. The filtration performance was determined on an air filtration stand which was used to measure efficiency and capacity at the end of a ten-minute test, and initial and differential restriction at an air velocity of 17 CFM

3:15 REFRESHMENTS

3:30 DESIGN AND MANUFACTURE OF NONWOVENS IN AUTOMOTIVE FILTRATION APPLICATIONS
Ed Homonoff, Director of Advanced Technology
Allied Aftermarket, East Providence, RI
This presentation will encompass a discussion of the design and physical characteristics of nonwoven filtration media for air and liquid filtration, as related to the automotive industry. Along with an overview of the manufacture of the material physical properties will be discussed as related to filtration performance.

4:00 **QUESTION-AND-ANSWER SESSION**
(Featuring Speakers of the Afternoon)

4:30 SUMMARY AND ADJOURNMENT

5:30 SOCIAL HOUR Ramada Inn

nts In
CHNOLOGY

CHAIRMEN:
VENESH GOSWAMI, CLEMSON UNIVERSITY

Thursday, April 16

8:00 CONTINENTAL BREAKFAST

MODERATOR: Donald K. Werle, Product Manager, Flex-Kleen Corporation, Chicago, IL

8:40 FILTERING ECONOMIC DATA FROM THE TEXTILE FIBER ECONOMY
Richard D. Karfunkle, President and Chief Economist,
Econoviews International Inc. Wilmington, DE
The outlook for the textile fiber economy will be determined by domestic business activity, and international trade flows These aspects will be discussed, and forecasts for the next five years will be presented.

9:20 BICOMPONENT FIBERS USED IN FILTRATION
Drew Willoughby, Product Manager, CUNO, Inc., Meriden, CT
This presentation will focus on the reasons why bicomponent fibers enhance filtration, and will detail areas in which these fibers are used, as well as how they are used.

10:00 REFRESHMENTS

10:15 THE PERFORMANCE VALUE OF EXPANDED PTFE FIBERS AND FABRICS IN HOT, HARSH ENVIRONMENTS
Michael E. Johnson, Sales/Marketing Associate, W. L. Gore & Associates, Inc., Fibers Division, Elkton, MD
This presentation will concentrate on the benefits of filtration fabrics and scrim support fabrics woven from PTFE fibers in hot, harsh environments, and will describe how they dramatically outlast fabrics and scrim fabrics woven from conventional fibers

10:45 ENGINEERED MONOFILAMENTS FOR FILTRATION
Frank Hollowell, Marketing Manager, Shakespeare Monofilament Division, Columbia, SC
Present monofilament usage in filtration will be emphasized, with focus on engineering media for both static and dynamic filtration applications Potential modifications of monofilaments for various designed end results will be discussed

11:30 THE DUSTRON: AN AUTOMATED FLAT SAMPLE FILTRATION PERFORMANCE TESTING SYSTEM
James E. Moulton, III, Development Engineer, Hollingsworth & Vose Company, Greenwich, NY
A proven microprocessor-controlled test system called the HV Dustron will be discussed, demonstrating its utility in product creation and improvement.

12:00 **QUESTION-AND-ANSWER SESSION**
(Featuring Speakers of the Morning)

12:30 LUNCH

1:30 FILTRATION IGNORANCE EQUALS CAVEAT EMPTOR
Donald H. Olds, President, Olds Filtration Engineering, Inc., Daphne, AL
This presentation will offer a look at some of the stumbling blocks that prevent desired filtration results, and will present practical filtration solutions learned through experience.

2:15 FABRIC FILTRATION: BRIDGING THE GAPS BETWEEN FIBER MANUFACTURER AND END-USER
Theron Grubb, Filtration Consultant, Grubb Filtration Testing Services, Inc., Delran, NJ
Case histories will be cited, to illustrate the need for better mutual understanding and greater technology transfer within the fabric filtration industry and its allied industries. Previous filtration developments, and an overview of opinion regarding current and future needs of the industry will be presented

2:45 REFRESHMENTS

3:00 AIR FILTRATION IN TEXTILE PLANTS
Harry S. Barr, Vice-President, Research & Development, Pneumafil Corporation, Charlotte, NC
An overview of current air filtration practices in the textile industry will be given, along with a discussion of some currently used filtration media A brief description of Pneumafil's Automatic Panel Filter will be given, including the theory of operation and application examples.

3:30 A CONTINUOUS AEROSOL MONITOR FOR MICROWEIGHING AND SIZE ANALYSIS OF LINT PARTICLES
Arthur C. Miller, Jr., President, ppm, Inc., Knoxville, TN
Operating characteristics pertaining to a new adaptation of the CAM family of continuous aerosol monitors for weighing and sizing lint particles will be discussed This CAM lint analyser utilizes light scattering to determine weight with nanogram sensitivity Particle count and cumulative fractional mass information in 9 channels is provided for lint from 19-4 800 microns length.

3:45 THE EVALUATION OF FILTER PERFORMANCE USING SEM EDS
Michael Ellison, School of Textiles, Clemson University
This presentation will focus on the use of characteristic x-ray emission spectra of elements in dust filter challenge material, used along with SEM to ascertain the performance of layered filtration media.

4:10 **QUESTION-AND-ANSWER SESSION**
(Featuring Speakers of the Afternoon)

4:30 SUMMARY AND ADJOURNMENT

WHO SHOULD ATTEND

Technologists, fiber and industrial fabric manufacturers, scientists, engineers, filtration process personnel, and personnel in the baghouse, utility and automotive industries will find this conference extremely valuable for future progress.

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DEVELOPMENTS IN FILTRATION TECHNOLOGY

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SAVE ON AIR TRAVEL Eastern Airlines has been designated the official airline for the Filtration conference. As a participant in this conference, you or your travel agent may call 1-800-468-7022 (in Florida, call 1-800-282-0244) for a guaranteed 50% discount on normal coach fares, or best applicable excursion fare, whichever is lower. The Eastern desk is open Monday through Friday from 8 a.m. to 9 p.m. EST. When you call, please refer to E-Z access number 14DP17 to qualify.

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ACCOMMODATIONS Rooms and meals, with the exception of luncheons, are at the participant's expense. (Call the RAMADA INN at 803-654-7501 requesting a written confirmation to make your reservation.) Please identify yourself as a participant in this Clemson University conference to qualify for the special room rate for participants. Alternate accommodations are available at the Holiday Inn on Highway 123 in Clemson. Call (803) 654-4450.

CONTINUING EDUCATION UNITS Clemson University awards Continuing Education Units (CEUs) to participants in Professional Development courses. CEUs are computed on the basis of one unit for each ten hours of non-degree, short course work. Units are recorded to one decimal point. Participants in this course will receive 1.2 CEUs.

ON-SITE PRESENTATIONS: Clemson University is prepared to present a number of its textile conference topics to 10 or more people at your plant, here in Clemson, or at other select locations. We can present much of the same material covered during the conferences, or we can customize presentations according to subject matter or length of time. For more information, contact Jud Hair, 803-656-3985, or Doug Bowen, 803-656-3978.

— — — — — — clip and mail panel to Clemson University address below — — — — — —

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